Follow-up Study on Surgery of Cervical Central Disk Protrusion

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Follow-up Study on Surgery of Cervical Central Disk Protrusion

by

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INTRODUCTION

Our Orthopedic Department has shown a special interest in the surgery of spine from the early days. Thus the first report on the operated "cervical ecchondrosis" in Japan was released from our department by Nozaki in 1935.

Following this Professor Maeda & Iwahara's report on surgery of spine appeared in 1937, though interrupted by the war, myelogrophic study of central cervical disk protrusion by Inoue & Izumida in 1950, and serial works concerning cervical spondylosis by Izumida et al. ensued in the recent years.

Up to date we accumulated 34 cases of the operated cervical central disk protrusion from 1935 to 1961, and through this time our principle of the surgery is that full laminectomy with removal of protruded disk in soft, and full laminectomy with section of dentate ligaments without any attempt to remove bony nodule in hard disk.

I made the follow-up study of our 34 cases in May 1962, and found that the number of our operated cervical central disk protrusion is larger, and their operative results are excellent, compared to the hitherto reported cases.

Therefore, I reported and reviewed this condition in the light of the literature and my experience of the anterior approach to this disorder.

MATERIAL AND METHOD

Of the 34 cases comprising this series, 5 were recorded from 1935 to 1937, and the remaining 29 cases were encountered at the Department of Keio University Hospital from 1945 to 1961.

Only those patients in whom spinal cord compression due to central cervical disk protrusion could be demonstrated at operation were accepted. The term "central cervical disk protrusion" is usually applied to the wide variety of lesions, but as it does really mean, here the spinal cord compression syndromes, which are attributable to the well localized cervical ventral mass, either soft or hard, which was considered the frank rupture of cervical disk and its presumably calcified nodule found at operation, were meant.

The follow-up examination was made in May 1962, Of the 34 cases, 16 were examined by myself, 14 were followed by mails and records in the hospital chart, and

4 could not be followed up by any resorts.

Among the followed 30 cases, 20 have been followed over periods ranging from one year to 10 years, and 10 cases are followed for 4 to 12 months.

AGE AND SEX INCIDENCE

The ages of the patients at the time of diagnosis are shown in Table 1.

Table 1

	20～29	30～39	40～49	50～59	60～	total
Male	1	5	11	10	3	30
Female	0	2	1	1	0	4
Total	1	7	12	11	3	34

The youngest was 26 and the oldest 63. The mean age is 47.

The predilection in middle and old age clearly contrasts to the lumbar disk.

30 were males and 4 were female, a ratio of 7.5 : 1.

Any difference about age and sex incidence between soft and hard disk could not be found as Table 2.

Table 2

	20～29	30～39	40～49	50～59	60～	Total
Soft Disk	1	3	8	8	2	22
Hard Disk	0	4	4	3	1	12
Total	1	7	12	11	3	34

OCCUPATIONS

In our series 17 patients engaged in teaching, sedentary work, and house-keeping, the work considered to be light.

7 engaged in merchant and salesman, the occupations of medium-severity. 10 engaged in farmer, motor-driver, and fireman, the occupations of hard labor.

There were no correlation between this condition and severity, or special type of occupation.

RELATIONSHIP TO TRAUMA

In 9 cases the patients give a definite history of a fall or head injury which preceded the onset of symptoms by months or years (26%).

In remaining 25 cases (74%) there was no history of the similar trauma elicited. It is interesting to find that 5 cases in 12 hard disk had a history of trauma (40%), meanwhile only 4 cases in 22 soft disk had a history of trauma (19%).

Namely hard disk seems to be a more sequelae of trauma than soft disk (Table 3).

Bucy et al. states that injuries to the neck are the primary etiological factors in this disease, yet the fact remains that injuries in the central disk protrusion seem to play a part only in 26% in our cases.

Table 3

	Previous Trauma (+)	Previous Trauma (−)	Total	Trauma (+)
Soft Disk	4	18	22	19%
Hard Disk	5	7	12	40%
	9	23	34	

MODE OF ONSET

The interval which elapsed between the onset of the first symptoms attributable to central cervical disk protrusion and the time at which the patients were seen was extremely variable, ranges from 2 months to twenty-two years.

Except two it was possible to ascertain this and it was up to six months in 5, seven to twelve months in 9, thirteen months to two years in 8, between two and five years 6, and more than five years in 4.

There were quite precise difference in the interval from the onset to the time of diagnosis between hard and soft disk.

Table 4 shows an acute onset of soft disk protrusion, ranging 2 months to within

Table 4

	Within 1 year	1 year~	2 year~	3 year~	4 years~	5 years~	6 years~	
Soft Disk	8	7	7	0	0	0	0	22
Hard Disk	2	1	1	1	1	1	2	12

two years with the average interval of one year and one month, whereas the interval of hard disk is beyond two years after the onset in two thirds of the cases with the average interval of 4 years.

A list of the initial symptoms is given in Table 5.

The patient's first indication of the disease appeared in upper limb in 14 cases (42%).

Table 5

1.	Upper Limb :	14	42%
	Dysaesthesia	8	
	Dysaesthesia & Clumsiness of Fingers	3	
	Clumsiness of Fingers	1	
	Neuralgic Pain	2	
2.	Neck & Shoulder :	9	29%
	Pain at the Base of Neck & Shoulder	7	
	Neck Muscle Spasm	2	
3.	Leg :	9	29%
	Weakness	3	
	Dysaesthesia	3	
	Dysaesthesia & Weakness	3	

Dysaesthesia in fingers, most commonly in the fourth and fifth, and clumsiness of fingers are the featurous initial symptoms.

Usually both hands were simultaneously involved. Radiating pain to upper limb appeared in only two cases as an initial symptom.

Although the lesion is definitely in the cervical region, the initial symptoms appeared in neck and shoulder in only 9 cases (29%). 7 patients noted pain at the base of neck with or without extension into the shoulder. Out of seven some complained of pain initially along the medial border of scapula, as CLOWARD, pinching the annulus fiber of C4-5 or C5-6, caused the pain. 2 patients complained of neck muscle spasm.

An initial symptom appeared in the leg in 9 cases (29%).

Weakness and dysaesthesia of the leg were equally complained of as a first symptom in the leg against sensory predominance in upper limbs as an initial symptom.

CLINICAL FEATURES AT THE TIME OF DIAGNOSIS

Table 6

	Number of Cases
1. Neck	
Neck and Shoulder Pain	12
Limitation of Neck Movement	16
Electrical Shock Symptom	5
Horner's Syndrome	2
2. Upper Limb	
Dysaesthesia	34
Upper Limb Pain	11
Abnormal Cutaneous Sensation	32
Clumsiness of Hand	32
Weak Grip	25
Wasting of Muscle	19
Muscle Fasciculation	8
Abnormal Reflex	30
3. Chest & Abdominal Features	
Abnormal Cutaneous Sensation	20
Abnormal Abdominal Reflex	17
4. Leg	
Abnormal Gait	31
Abnormal Reflex	34
Ankle Jerk Present	31
Knee Jerk Present	10
Babinski's Sign	18
Dysaesthesia	31
Abnormal Cutaneous Sensation	32
5. Sphincter Disturbance	
Urinary Disturbance	14
Bowel Disturbance	11

The clinical features of this disease presumably depend upon the location and size of the protrusion disk, as STOOKEY classified the symptoms in 1940, but the subdiary factor such as interfered vascular supply or secondary meningeal adhesion modifies them.

Therefore central cervical disk, although discrete lesion, presents a pleomorphic clinical picture similiar to the varied pattern seen with cervical spondylosis.

In addition, those with single lesions at a given level do not necessarily have a constant pattern.

For simplicity the clinical symptoms and signs are described according to the presenting part. This is given in Table 6.

1) *Neck Features*

Symptoms in the neck were present in 16 cases (50%).

This emphasizes the difference between cervical and lumbar disk lesions.

Pain, aggravated by neck movement were complaind of by the 12 cases.

The neck was examined and the commonest finding was limitation of movement which was present in 16 cases all movement were restricted in 7 patients and hyperextension were limited in 4 patients.

MÜNZER (1935) first reported the electrical shock symptom with cervical spondylosis and 5 of our patients had experienced it.

Neck extension or flexion was usually provocative factors.

Whether this is the same sensation as LHERMITTE's sign in multiple sclerosis, is subject to question.

Occasionally neck pain extended to the occiput and ipsilateral side of face to produce headache but this was never deep.

Ipsilateral HORNER's syndrome was noted in two cases.

2) *Upper Limb Features*

Eleven (30%) reported dysaesthesia with or without clumsiness of fingers as the first indication of the disease, but at the time of diagnosis dysaesthesia were complained in 34 cases (100%).

This commonest complain was present usually in the digits of both side, and most commonly the fourth and fifth (60%), the thumb and second digit or the whole hand, with spread occasionally to the forearm and shoulder regions.

Eleven patients, including root pain extending to the arm and electrical shock symptom, experienced the pain in upper limbs.

Cutaneous sensation was affected in upper limbs of 32 patients (94%) and usually involved bilaterally (84%).

The commonest pattern of affected cutaneous sensation included the ulnar two fingers and border of the hands, with extension to the forearm in some.

Several authors have reported this cutaneous sensory pattern in the ulnar side of the hand, regardless to the level of disk lesion.

TSURUMI et al. explains that as MAIR and DRUCKMAN showed the ischemic change at C5 or C6 segment in the ventral half of posterior column, where the touch fibers to the fourth and fifth finger (C7, C8) are present. A posterior column sensory defect was

also present, but a dissociation between touch and pain-temperature was not found in any case, although TILNEY and ELSBERG (1926) said to be frequently present with ventral compression of the spinal cord.

Joint position sense, two-point discrimination, vibration sense were not examined at this time.

Motor feature of upper limb was also characteristic as well as its sensory complaints.

Clumsiness of fingers appeared as an initial symptoms in only four with or without dysaesthesia, but at the time of diagnosis thirty-two cases (94%) had it and only two of our patients were without it. Usually it involved both hands.

Although weakness of upper limbs was not so conspicuous as in the legs, twenty five paients (75%) had it by the time the diagnosis was made. Weak grip, weak biceps or triceps were found, occasionally it deveoped to drop hand in two and weak deltoid muscle in one. Muscle wastings were noted in the small muscle of the hands in 14 patients, and in forearm and shoulder girdle in 5 cases. Totally it was present 60%, but it was never severe.

Muscle fasciculation was found in 8 cases. It was present mostly in deltoid, triceps, and forearm muscles.

The arm reflexes supplied useful information concerning cord and root lesions. Twenty-two patients (65%) had increased triceps, biceps and radial reflex.

This group was considered to have cord lesion above C5.

Eight patients had diminished triceps or biceps reflex of the arms. These cases presumably indicated either C6 or C7 root lesions.

The remaining four patients had normal upper limb reflexes.

Trophic disturbance of nail was found only in one case and edema of hands was noted in several cases.

3) *Chest and Abdominal Features*

Sensory impairment involved trunk in 20 cases (60%) of our cases.

The upper limit of sensory abnormality was demonstrated below T2 in 8 cases, below C4 in 5 cases, below T10 in 5, and below T4 in 2 cases, several segments below the site of protruded disk.

All cases except one described that the sensory impairment ascended from toes. Side of the main sensory abnomality usually coincided with the side of the weakmess in the leg.

The patients who had sensory involvement of trunk had experienced constricting upper chest pain at some time during the course of disease, which had the similarity to the pain in angina pectoris.

Motor feature at chest and abdomen was not so conspicuous as in the legs. Weakness of abdominal muscles was noted in advanced cases. Abnormalities of abdominal reflexes were present in 17 cases (50%), in which 8 cases showed bilateral absence of the reflexes, and 9 cases showed the partial abolishment.

The observation showed that cremaster reflex remained active despite of absent abdominal reflexes.

4) *Leg Features*

6 reported weakness of the leg as the first indication of the disease. Motor impairment of the legs was conspicuous and common, as compaired to upper limb, in this condition.

31 of our patients (93%) showed abnormal gait at the time of diagnosis. 18 cases (60%) were able to walk unaided but their gait were unstable in appearance.

5 (16%) could walk only with support and were severely disabled.

5 (16%) were completely bedridden and in each the history was lengthy. The remaining 3 patients had no recognizable abnormal gait. Spasticity and weakness of the legs were easily appreciated when the patient was seen walking.

Leg reflexes were always abnormally exaggerated, but Achilles tendon reflex abolished in 2 and drop-foot was noted in one case possibly due to the associated lumbar root damage.

Other signs indicating involvement of corticospinal tract were : ankle jerk demonstrated in 31 cases (90%), knee-jerk in 10 cases (30%), and positive BABINSKI's sign in 18 cases (60%).

Wasting of the legs was attributed to disuse, or to an associated disk lesion. No muscle fasciculation was found.

Sensation of the legs was less severely affected, compared to the motor features, but dysaesthesia was complained of in 31 cases (93%) in the legs. It began from the toe or from the sole of foot, ascending toward proximally.

Cutaneous sensory disturbance was demonstrated in the legs of 32 cases. 11 cases (33%) among the 32 it remained in the domain of the legs.

Bilateral posterior cord and spinothalamic tract lesions usually existed, however, they tended to appear marked in the legs on which pronounced motor feature existed. Asymmetry was a rule.

A dissociation between touch, and pain and temperature was not found.

5) *Sphincter Disturbance*

The frequency of urinary disturbance in this disease has been variously reported by different authors.

14 cases of (44%) our patients had bladder symptom, but they were never a presenting complaint and very rarely severe.

Urgency and hesitancy were commonest.

The impression was given that it appeared at later stage of this disease and may reflect the amount of pyramidal tract involvement.

Bowel complaints were noted in 11 cases (35%).

Sexual functions had not been assessed on all.

2 of our patients complained of numbness of penis and impotentia.

LEVEL DIAGNOSIS AND CLINICAL DIFFERENTIATION BETWEEN HARD AND SOFT DISK

A protrusion of C3 and C4 disk will compress the spinal cord above the cervical enlargement, while a protrusion of C4 and C5 disk will compress the cervical enlargement

at its upper limit.

Actually, however, central disk protrusion at a given level had no particular pattern, and in most cases the upper level of the sensory loss often bore little or no relation to the level as well as motor sign. Level diagnosis was almost impossible clinically and therefore it is to depend upon myelography and/or discography.

The symptoms and signs in hard disk and soft disk have many similarity. Therefore the clinical differentiation is made only on the basis of presumption. Rapid progress plus abundant signs of spinal cord lesions denoted soft disk, whereas hard disk simulated the clinical picture of chronic myelopathy, secondary to cervical spondylosis.

INVESTIGATIONS

1) *Cerebrospinal Fluids*

The cerebrospinal fluids were examined in 23 cases.

Physical properties : The pressure and color were normal.

QUECKENSTEDT's maneuver :

It was completely positive in 3, and partially positive in 3.

Postural manometry (KAPLAN and KENNEDY 1950) was not carried out.

Cells : Pleocytosis was noted in some cases, but it was never severe.

Protein : Protein was examined in 20 cases. PANDY's test was positive in 13 (65 %) and NONNE's test was positive in 3 (15%).

The protein concentration in the cerebrospinal fluids remained at 30 to 50mg/dl in most cases.

Glucose : It was examined in 6. All 6 cases showed slightly raised glucose level, ranging 78mg/dl to 81mg/dl

On the whole the abnormal cerebrospinal fluid findings in this condition were rare, contrasting to the well-known findings in the spinal cord neoplasm.

2) *Electromyographic Examination*

Electromyographic recordings at rest and voluntary contraction were taken and central or peripheral abnormalities were noted in all cases. Apparently E. M. G. was less effective localizing way than myelography.

3) *Radiological Features*

Plain x-rays of the cervical spine were available in 19 of our cases. Although WATSON and BROWDER and others have reported normal roentgenological appearances in this disease, there were abnormalities in each, ranging from cases straightening of cervical curve on a lateral film to widespread spondylotic changes.

Table 7 gave a list of roentgenological findings and their frequency.

Anterior lipping of the body in 80% and narrowing of the intervertebral disk in 70% were the commonest roentgenological findings.

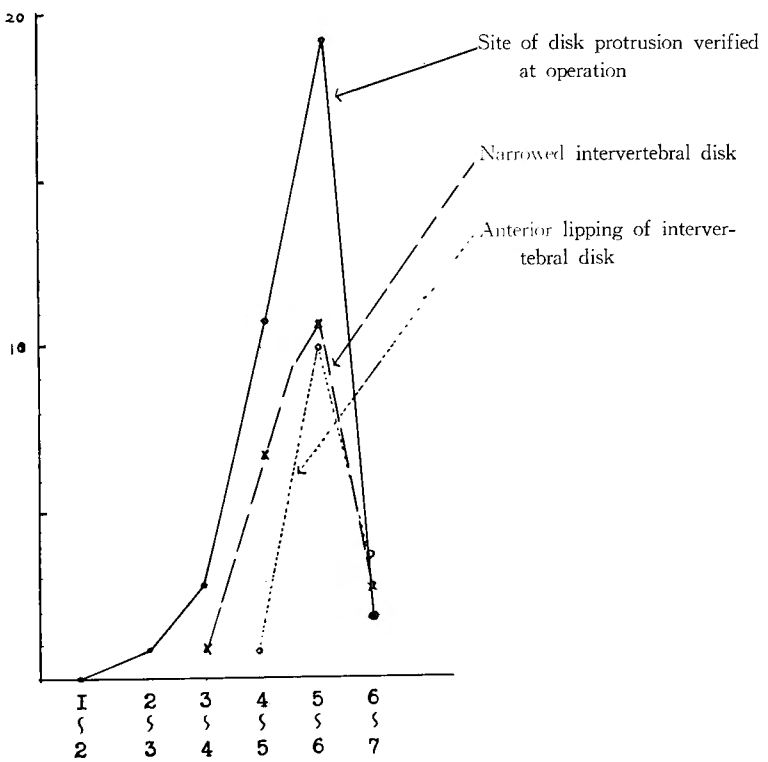
Posterior spurs were most easily seen in the oblique roentgenograms. Fig. 1 showed correlations between the site of anterior lipping, narrowing of intervertebral disk, and the site of disk protrusion verified at operation.

It is clear from this figure that the three frequency curve run parallel and C5-6 was the site of the most frequently damaged intervertebral disk roentgenologically and surgically.

Table 7

Cervical Curve	
Straightening of Cervical Curve	1
Increased Lordosis	2
Reversed Lordosis	5
Normal	11
Barsony	
Present	2
Normal	17
Narrowing of Intervertebral Disk	
Narrowed	13
Normal	6
Anterior Lipping of Intervertebral Disk	
Present	15
Normal	4
Posterior Spurs in Oblique Position	
Present	10
Normal	9
Constricted Intervertebral Foramen	
Constricted	11
Normal	8

Fig. 1



These abnormalities were frequently noted in this disorder and may give a clue to the diagnosis and level of the lesion in some selected cases, however, those findings were not specific for this disease, and may occur in any person beyond middle age,

No inferences should be drawn from the simple x-ray alone.

4) *Myelography*

Myelography is the most important investigation.

Myelograms were available in 23 cases, using the technique of Professor IWAHARA (1937).

There were partial or complete blocks of the opaque material in all 23 cases. The typical myelograms indicative of central cervical disk protrusion was seen in 18 cases (74%).

There were a hold-up in the opaque marterial, which figures were H or reversed U.

Shaded blood vessel of spinal cord and root sleeve were very often visible on the anteroposterior projection.

The anterior indentations of the opaque column were seen in 80% on lateral films, corresponding to the extruding disk protrusion.

The remaining 2 cases showed the myelogram indicative of meningeal adhesion, and one case shows the complete retention of the oil in the cistern, indicating a disk protrusion at C2-3.

TREATMENT

In acute prolapse of the central disk the surgery should be done at the earliest possible moment before irreversible change can occur in the spinal cord.

However, medical treatment of neck traction should not be neglected, especially in chronic myelopathy secondary to hard nodules or cervical spondylosis. BRAAF et al. and others state that the results of neck traction in spondylotic patients are excellent in 80%.

Surgical treatment :

Two types of the operative procedure were used : full laminectomy with section of dentate ligaments in hard nodule, and full laminectomy with section of dentate ligaments plus removal of ruptured disk material in soft disk. No attempt is made to remove the cord compressing osteophytes at the anterior wall of the spinal canal, which was advocated by ALLEN (1952).

Laminectomies under intubation anaesthesia were carried out at least one or two laminae above and below the lesion. After opening the dura, the adjacent three pairs of dentate ligament were sectioned, the nerve roots and cord mobilized so that retraction of the cord could be carried out without too much pressure, and the extruded fragments were removed by the transdural approach. In case of hard nodule any attempt to chisel off the nodule were resisted.

Opertive Findings :

The operative findings, with the site of disk protrusion were summarized in Table 8.

These findings have been seldom mentioned in the literature. A hypertrophic laminal arch was found in two cases, the epidural fat was absent in 9, arachnoid adhesions were found most commonly in 17, and increased vascularity and dilatation of the

Table 8

	Total	Midline	R-Paramedial	L-Paramedial	Bilateral
C 1—2	0	0	0	0	0
C 2—3	1	1	0	0	0
C 3—4	3	2	1	0	0
C 4—5	11	4	5	0	0
C 5—6	19	9	5	4	2
C 6—7	2	0	1	1	1
	36	16	12	5	3

blood vessels of the cord in 8. Marked flattening of the spinal cord in 6, and posteriorly displaced spinal cord due to extruded disk in 7. Apparently atrophic spinal cord in 5, atrophic cord with softening in 4, were found.

The site of disk protrusion verified at operation were C5-6 53%, C4-5 30%, C3-4 8%, C6-7 6%, and C2-3 3%, respectively.

Therefore C5-6 and C4-5 comprises 83% of our cases and occurrence of disk protrusion at the other sites were considerably low.

Disk protrusions were situated para-medially in 47%, on the midline 44%, and bilaterally 9%.

There were no difference between hard and soft disk with regard to the sites and situation of the disk protrusion.

Postoperative treatment consisted in bed rest in oxygen tent for 4 days, and the patients remained in supine position for further 3 weeks. Gradual reeducation exercise was instituted in convalescent periods. During this periods the transient radiating pain in upper limbs, and retention of urine were the most common complaints, but they did not continue for a long time.

Results of operation :

The operative results of the followed up 30 cases were evaluated, and classified arbitrary into 6 groups according to the following criteria. 20 cases have been followed over periods ranging from one year to ten years, and 10 cases have been followed for 4 to 12 months postoperatively.

1) Fully recovered in 9

Excellent functional improvement gained, and the patients returned to normal life.

2) Markedly recovered in 7.

Satisfactory functional improvement gained, and the patients conducted himself well in daily activity.

3) Slightly improved in 6.

Functionally improve after the surgery, but the patients were limited in daily activity.

4) No improvement in 5.

5) Worse in 1.

6) Death occurred in 2.

One died one month after the surgery because of symptomatic psychosis, and the other died of urogenital infection 8 months postoperatively.

Therefore 18 patients out of 30 (60%) were benefited from the operation and 12 patients out of 30 (40%) were fully or markedly recovered.

In some cases the neurological deficit had been increased. This may be attributable to the aberrant blood vessels coursing between the pia and the arachnoid that were associated with an arachnoiditis, and a significant portion of the blood supply with some degree of vascular insufficiency may depend upon these aberrant blood vessels. The dissection of the adhesion at operation may disturb the above mentioned vessels.

The symptoms and their frequency before and after the surgery were compared in Table 9.

Table 9

	Before	After
Neck		
Limitation of Neck Movement	66%	18%
Neck, Shoulder Pain	40%	5%
Electrical Shock Symptom by Tapping	0%	40%
Upper Limb		
Dysaesthesia	100%	34%
Abnormal Cutaneous Sensation	91%	50%
Clumsiness of Finger	93%	36%
Weak grip	75%	20%
Wasting of Muscle	60%	20%
Chest and Abdomen		
Abnormal Cutaneous Sensation	60%	50%
Abnormal Abdominal Reflex	50%	57%
Leg		
Abnormal Gait	93%	26%
Abnormal Reflex	100%	78%
Ankle Jerk	90%	50%
Babinski's sign	60%	26%
Dysaesthesia	93%	39%
Abnormal Cutaneous Sensation	93%	50%
Sphicter Dinsturbance		
Urinary Disturbance	44%	0%
Bowel Disturbance	34%	9%

Neck : The symptoms in the neck were relieved in most cases, but shock syndrome produced by tapping the neck were noted postoperatively in 40%. This was attributable to the loss of bony covering after laminectomies.

16 cases of the postoperative X-rays were available and no unstable spine was found.

Upper limb : Motor and sensory function in upper limb showed complete recovery in roughly one-third of the cases. On the other hand, reflexes of upper limb showed no appreciable improvement after laminectomy. They were hyperactive in 87% postoperatively.

Chest and Abdomen : Sensory symptoms at chest and abdomen were not remarkably relieved, abdominal reflexes were absent in 57%, increasing postoperatively.

Legs : Gait was apparently improved in a considerable number.

The reflexes of the legs also remained hyperactive, and ankle clonus was present in 50% still after the surgery.

Sensory recovery was seen in half of the cases. One case showed a complete dissociation of sensation with preservation of touch and loss of pain and temperature.

Sphincter disturbance : This was relieved in all cases which showed recovery.

On the whole, the follow-up cases showed definite improvement in functional activity, but on examination the sign of the involvement of corticospinal and spinothalamic as well as posterior column remained more or less in every case. These findings were compatible with the postoperative electromyographic study made by our colleague, TANABE.

Relationship of results to various factors.

Relationship of the operative results were sought to various factors, and the four points were highly significant.

1) Cord lesions of soft disk were relieved in 90%, on the other hand that of hard disk had far less satisfactory operative prognosis. The chance of recovery after the surgery were in only 50% (Table 10).

Table 10

	Fully Recovered	Marked	Slight	Unchanged	Worse	Death	
Soft Disk	8	3	5	1	0	1	18
Hard Disk	1	4	1	4	1	1	12
	9	7	6	5	1	2	30

2) Successful removal of soft extruded disk material brought a dramatic improvement, but soft annular protrusions which could not be removed successfully in four, had not been relieved efficiently (Table 11).

Table 11 Soft Disk

	Full	Marked	Slight	Unchanged	Worse	Death
Successful Removal	8	2	2	1	0	1
Unsuccessful Removal	0	1	3	0	0	0
	8	3	5	1	0	1

3) The chance of improvements were greater in those whom the disease was discovered within two years after the onset of the diseases (Table 12).

Table 12

	Full	Marked	Slight	Unchanged	Worse	Death	
Severely Affected	2	1	3	1	1	2	10
Moderately Affected	2	3	2	2	0	0	9
Slightly Affected	5	3	1	2	0	0	11
	9	7	6	5	1	2	30

4) As might have been expected the chance of improvement were greater in those who were less severely affected (Table 13).

Table 13

	Full	Marked	Slight	Unchanged	Worse	Death	
Within I Year	4	0	2	0	0	0	6
1—2 Year	3	3	0	0	0	0	6
2 Years	2	1	1	1	0	1	6
3 Years	0	1	0	3	0	1	5
4 Years	0	1	1	0	0	0	2
5 Years	0	1	2	1	1	0	5
	9	9	6	5	1	2	30

Many articles have been written concerning disk lesions of the cervical spine, and yet the reported results of operation are few and various. The reported results ranges from 33% (SEMMES and MURPHEY'S 6 cases, 1954) to 85.1% (ODOM'S 14 cases, 1956) of the operative improvement. In our 22 soft disks improvement occurred in 88% and dramatic in 61%. Our results and the number of the operated soft disk were considerably higher than the reported series.

The author attributed our excellent results to the facts that these operations were carried out only by selected surgeons and that our operative policy was directed towards the utmost gentle care for the vulnerable spinal cord.

With regard to hard disk improvement in our 11 cases was obtained in 50%. This is comparable with the reported operative results of chronic myelopathy, secondary to cervical spondylosis, in which BRAIN reported 66% in 21 cases, CLARKE and ROBINSON 42% in 34 cases, and BRAAF and ROSNER 50%.

General principle of accurate diagnosis before irreversible changes occur in the spinal cord need not be stressed here again.

COMMENT

History: :

Surgical approach to cervical spinal cord lesions due to discogenic disease began only 60 years ago.

In 1892 acute traumatic type of cervical disk rupture was operated on by HORSELEY (TAY & COLLIER) and OPPENHEIMER and KRAUSE (1909) considered the lesion enchondroma. Thereafter, ADSON, ELSBERG and STOOKEY made the study of surgically treated ventral extradural chondromas.

Since the study of SCHMORL (1929) and AUDRAE (1929) it became apparent that the lesion was attributable to protruded disk.

KORTZEBORN (1930), ELSBERG (1931), MIXTER & BARR (1934), PEET & ECHOLS (1934) and LOVE & WALSCH (1938), dealing with disk prolapse in other parts of spine, established as a distinct entity cord compression by a prolapsed disk.

In 1943 SEMMES & MURPHEY reported lateral rupture of cervical disk as a common

cause of presistent neck and upper extremity pain, and since that time many authors had written on lateral disk rupture. (FRYKHOLM 1951, R, G, SPURLING 1954, ODOM & WOODHALL 1958).

On the other hand the neurological complications of cervical spondylosis were studied separately and were not associated with disk disease until recently. Many authors (MIXTER and BARR 1934, BUCY, HEIMBURGER and OBERHILL 1948) have failed to distinguish between acute disk rupture and cervical myelopathy secondary to cervical spondylosis.

Others have considered only the acute or subacute syndrome (SEMMER & MURPHEY 1954, MACDONALD, DODGE and CLARK 1955) increased the confusion.

Recently, there has been a renewed interest in the anterior approach, advocated by ROBINSON and SMITH (1954) and more recently by CLOWARD (1958). As to the causes of combined compression of cord and root, NUGENT (1958) and STÖRTEBECKER (1960), correlated the present knowledge with specific mention of a vascular ischemic component by BRAIN, MAIR and DRUCKMAN, and CLARKE and ROBINSON.

Pathogenesis :

It is a quite evident fact that the cord lesions in this disorder are primarily due to cervical protrusion and our surgical data showed that successful removal of protruded disk plus section of dentate ligaments brought an excellent results.

However, pathogenesis of this disorder is, in reality, a complex situation in which mechanical, vascular and other factors are involved.

KAHN (1947) stressed the role of the dentate ligaments, and mechanical factors in the pathogenesis of spinal cord injury from herniated intervertebral disk (BEDFORD et al. 1952).

NUGENT (1959) pointed out that adherent root sleeve which passes antero-laterally and holds the cord anteriorly, may have a similar effect.

Neck movement are obviously important and PAYNE and SPILLAE (1957), by anatomically dissecting the cervical spine, found that the mass at the anterior aspect of the spinal canal in spines with degenerative disease of the disk protruded even further into the spinal canal when the spine was extended. They added that the ligamenta flava bulge anteriorly at the same time. Those are especially important factor in hyperextension injury.

Some authors (GIRARD, GARDE and DEVIC 1954) have considered local arachnoiditis and extradural adhesions to be of etiological factor.

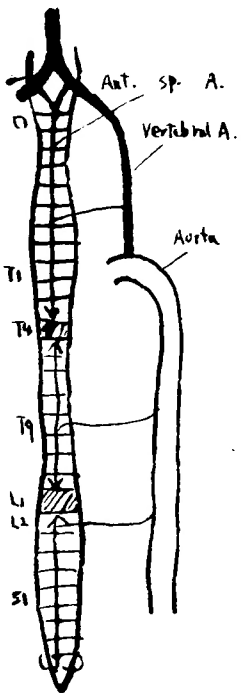
However, many authors in the recent ten years (BRAIN 1948, MAIR and DRUCKMAN 1953, BARTSCH 1954, CLARK and ROBINSON 1956, BRADSHAW 1957, STÖRTEBECKER 1960, C, R SCHNEIDER 1961, TÖNNIS 1961) have emphasized the role of vascular factor in these discogenic diseases.

BARTSCH (1954) observed that when his patient with severe spondylotic change of cervical spine was complicated with heart-failure, the sign of spinal cord involvement began at T4, which was relieved with the restoration of general circulation.

Explanations are : T4 area is known to be an area of poor blood supply, the critical portion between the supply of anterior spinal artery and anterior medial artery, so that

in his case the reduced blood supply by the cervical osteochondrotic change in the intervertebral foramina on one side and impaired general circulation by concomitant heart failure on otherside worked together to yield the first sign of spinal cord involvement in the area of the first hypoxemic area, namely T4.

Fig. 2



The following diagram shows the scheme of blood supply in the spinal cord. Anterior spinal artery supplies two third of cervical spinal cord and uppermost thoracic segments to T4 level (Fig 2).

Blood flow is caudal. The lateral arteries, branches of the vertebral artery, pass through the intervertebral foramina of the lower cervical and upper thoracic vertebrae, supplying the C7 through T2 spinal cord segments. And remainder of arterial supply for thoracic cord from T4 to L1 is by intercostal branches of aorta.

Lumbosacral portion is supplied by A. radicularis magna which comes in with the root D10, L1 or L2 in most cases.

SUH and ALEXANDER reported that the only completely efficient radicular arteries are present at the C6, T10, and L1 neural segments.

ZÜLCH presumed that poorest collateral circulation of the cord were at a zones of C5, T4 and L1.

TÖNNIS in his study of 285 traumatic spinal cord injury, correlated the site of vertebral body injury with upper limit of spinal cord injury.

The upper limit of spinal cord injury gathered at C5, T4, T10 and L1, regardless to the injured vertebral body.

In our cases also the sensory impairment at the ulnar border of hands suggests as stated before that ischemic change took place at the posterior column of C5 segment, and that upper limits of sensory impairment in chest and abdomen were several segments below the site of cervical protrusion, namely at C5, T2, T4, T10 and L1.

This predilections of affected neural segments in this condition are identical with the cases of TÖNNIS's spinal cord injury.

He adds that spasticity in traumatic cord lesion occurred 52% in the upper and middle part of thoracic, 34.5% in cervical, 29.0% in low thoracic, and most rarely 7.4% in lumbar spinal cord injury.

All of our cases showed more or less spasticity of lower limb, and it can occur from either cervical or thoracic involvement.

These facts can be explained by the previously mentioned vascular insufficiency in spinal cord.

When we now see the lesion due to disk protrusion on the transverse section of cord, MAIR and DRUCKMAN illustrated their autopsy cases in the following.

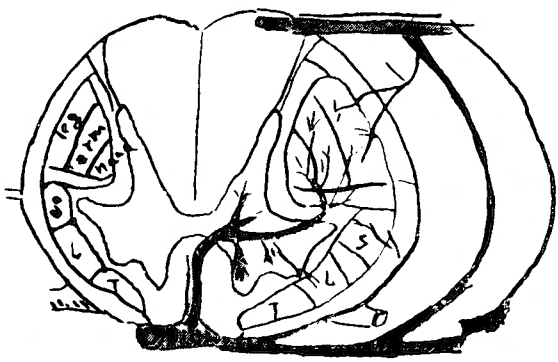
The distribution of the lesions in their cases was idential with the field of supply of

the anterior sulcus artery.

The distal ramification of the anterior sulcus artery will be the most affected since the compression force will exert a more marked obliterative effect upon vessels which are subjected to this force over a long distance.

So in Fig. 3 shows the sparing of the anterior columns, and more distal situation of the fibers to the anterior spinal artery may explain weakness appear earlier in a lower rather than an upper limb.

Fig. 3



The author has used anterior fusion in 3 cases in which chronic myelopathy due to cervical spondylosis was present.

Our operative procedure was designed and performed by SMITH and ROBINSON. Through anterior approach the intervertebral disk material and osteophytes intervening the space were curetted or chiseled off at the aimed disk level, in order to bring the space ready to be spread apart.

Then, while the prepared intervertebral disk space is widened as much as possible by help of head traction, the bone graft from ilium is inserted into the disk space. When it has been seated it should be stable. Immediate results were encouraging, 2 of the patients noted the recovery from the first operative day.

ROBINON states that it is possible that spine fusion in the anterior approach may, by stabilizing the degenerated portion of spine, decrease soft-tissue swelling over large posteriorly protruding osteophytes, or stop an irritation of the cord or of the anterior spinal artery.

However, my impression in this form of treatment for spinal cord lesion led me believe that the only significant surgical gain by our anterior spine fusion is restoration or widening of the constricted intervertebral foramen, and then these increased blood supply to the cord. The prompt recovery in our patients also convinced me that vascular factor played a major role in the symptom production in this disorder. The analysis of the clinical features and my experience in anterior spine fusion impressed me that vascular factor played a major role, however it should be remembered that this condition is primarily a mechanical disease and its consequent vascular disturbance furnishes the fundamentals of the clinical pictures.

SUMMARY

The 34 cases of the operated disk protrusion were presented. The clinical picture were a combination of discogenic syndrome, nerve root and cord compression syndromes.

The results of the laminectomy were assesed on 30, and the following outcomes were obtained : Excellent in 9, markedly improved in 7, slightly improved in 6, unchanged in 5, worse in 1, death occurred in 2.

Relationship of the operative results to various factors were sought and the following points were highly significant.

1) Operations were beneficial in cord lesions of soft disk in 90%, whereas the chances of recovery in hard disk were in only 50%.

2) The chance of recovery were greater in those less severely affected and in those the disease was discovered earlier.

Therefore the accurate diagnosis and earlier treatment should be instituted before the irreversible changes of the spinal cord appear.

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和 文 抄 録

頸椎椎間板ヘルニアの手術成績

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慶大整形外科に於いて，昭和36年迄に，Soft disk 22例，Hard disk 12例計34例の本症が手術された．前者に対しては腫瘤摘出，後者に対しては椎弓切除減圧減張を行なつた．予後を調査し，次の結果を得た．

1）全治9例，著効7例，軽快6例，不変5例，悪化1例，死亡2例である．

2）Soft disk に於ける手術効果は90%に認められるが Hard disk に於いては50%に過ぎない．

3）術前症状の重度でないもの，発症2年以内の症例の予後は，良好である．

したがつて本症に於ける早期確診と早期治療が強調されねばならない．